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(54) Grip surgical clip.

(57) The present invention is directed to a method of increasing the surface roughness or at least portions of surgical clips by applying coatings of material to the tissue gripping surfaces of hemostatic clips and/or to the outwardly directed faces of the blades of aneurysm clips. The material may include metal particles or ceramics. Preferable ceramics are alumina and even more preferable hydroxyapatite. The invention is also directed to the clips with such coatings applied thereto.

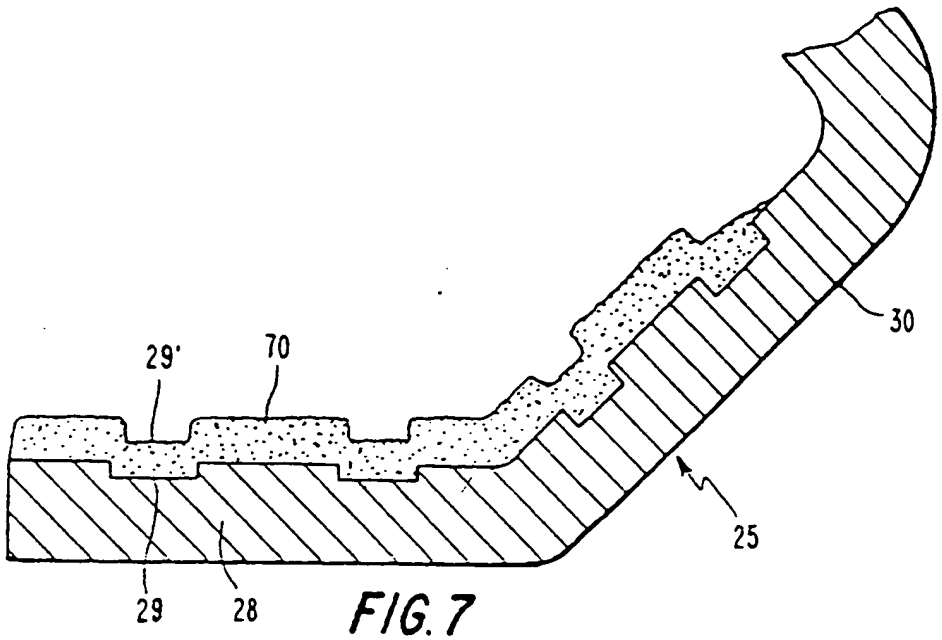

FIG. 7

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Figs. 16-18, a coating layer can be applied to the inner surfaces of the hemostatic clips while masking the end faces of the clips and the interior portion of the bail of the clips.

Fig. 19 is a schematic diagram of an apparatus for applying a coating, such as by plasma spray, to the hemostatic clip wire before the wire is cut and the wire pieces formed into individual clips. Wire enters the apparatus from the left where it is straightened through a series of rollers 120 and then moves through a heart shaping station 122. The heart shaping station comprises a series of rollers and the longitudinal groove is coined in place. As the heart shaped wire proceeds through the apparatus it moves under the embossing wheel 124 which impresses the serrations across the longitudinal groove into the regions 24 of the heart shaped wire. The embossing wheel comprises a series of hard metal protrusions 126 which are equally spaced apart and do not extend completely around the circumference of the wheel. This leaves a space on the wheel larger than the spacing between adjacent protrusions. This space corresponds to the apex of the bail portion 30 of the hemostatic clip when the clip is formed.

The wire, after passing through under the embossing wheel 124, passes by the coating station 128. A source of coating material such as a plasma spray 130 is directed toward the longitudinal groove of the heart shaped wire. A slotted band 132 passes around rollers 134, 136 and 138 to pass between the plasma spray and the heart shaped wire. The drive wheel 134 for the coating station is slaved to the embossing wheel to rotate in synchronization therewith. The slotted band comprises a series of rectangular slots 140. Where ever the slot occurs the plasma spray or coating will pass through the slot onto the heart shaped wire. The remaining part of slotted band masks the heart shaped wire from the coating spay. The slots are shaped and spaced to lay a desired pattern of coating on the wire such that when the wire is cut into the clips and the clips are formed, the coating will be strategically placed on the desired surfaces of the clip.

The slots could be shaped so as to provide a coating across the entire tissue gripping surface of the legs 28 of Fig. 1 in a pattern like that shown in Figs. 7 and 8. Alternatively, the slots can be formed to allow a coating to be placed only in the longitudinal groove 26, but not across the peaks of the regions 24 as shown in Fig. 11.

It may be desirable to interrupt the coating along the longitudinal groove of the clip as shown by the interruptions 33 in Fig. 10. When the clips are first formed or when the clips are applied, certain regions of the wire undergo certain stress which may cause portions of the coating to loosen or flake off of the clip. This may be avoided by eliminating the coating from the regions of the stress when the wire is cut before the clips are formed. The apparatus of Fig. 19 using the slotted band in synchronization with the embossing wheel can be used to apply the appropriate pattern of interruptions to the coating applied to the clips.

Claims

1. A method of increasing the tissue gripping characteristics of a surgical clip comprising the step of:

   increasing the surface roughness of at least the tissue gripping surfaces of the clip by fixedly attaching a layer of material on at least the tissue gripping surfaces of the clip.

2. The method of claim 1 wherein the clips are metallic clips and the material comprises metallic particles.

3. The method of claim 2 wherein the method comprises:

   applying a mixture of metallic particles and a suitable binder to the tissue clamping surfaces of the clip;

   drying the coating on the clip at a low temperature;

   heating the coated clip to a temperature where the binders burn off for a pre-determined period of time; and

   then raising the temperature to the sintering temperature for the metals being used.

4. The method of claim 1 wherein the material comprises a ceramic material.

5. The method of claim 2, 3, or 4, wherein the step of fixedly attaching comprises spraying said clips with a plasma spray.

6. The method of claim 2, 3, or 4, wherein said step of fixedly attaching comprises attaching said layer with a physical vapor deposition process.

7. The method Of claim 2, 3, or 4, wherein said step of fixedly attaching comprises attaching said layer by glueing with a surgical glue.

8. The method of claim 5 cross-referenced to claim 2 or 3, wherein said clips comprise titanium and said particles comprise titanium particles and said step of spraying with a plasma spray includes spraying in a low pressure or inert gas chamber.

9. The method of any one of claims 1 to 8, wherein the method further comprises heating the coated clips after the layer has been applied.

10. The method of any one of claims 5, 6 or 8, wherein said method further comprises masking portions of the clip to avoid coating said masked areas.

11. The method of claim 9 or 10, wherein the coating along the tissue gripping surfaces of the clip is interrupted in predetermined locations to avoid chipping of the coating from the clip when the clip is formed or applied.

12. A hemostatic clip comprising a pair of arms interconnected at one end and opened at the other with the arms arranged in laterally spaced apart substantially parallel relation, each of said arms having a side facing inwardly, said hemostatic clip further comprising a layer of material on at least said inwardly facing sides of said arms which increases the surface roughness of the tissue gripping surfaces of the clip.

13. The clip of claim 12 wherein said material comprises metal particles.

14. The clip of claim 13 wherein said clip comprises stainless steel and said metal particles comprise stainless steel.

15. The clip of claim 13 wherein the clip comprises titanium or tantalum and said metal particles comprises titanium.

16. The clip of claim 12 wherein said material comprises a ceramic.

17. The clip of claim 16 wherein said ceramic comprises hydroxyapatite.

18. The clip of claim 16 wherein said ceramic comprises alumina.

19. The clip of claim 16, 17 or 18, wherein said ceramic comprises a biocompatible glass material.

20. The clip of any one of claims 15 to 19, wherein each of the inwardly facing sides of said arms comprises at least one longitudinal groove and at least one cross-wise serration.

21. The clip of claim 20, wherein each of said arm portions is generally triangular in cross-section with the apex of said triangular cross-section facing outwardly in the opposite direction from said inwardly facing side.

22. The clip of claim 20 or 21, wherein said material is applied only within said longitudinal groove.

23. An aneurysm clip comprising:

a pair of clamping arms having proximal and distal ends and having opposed clamping faces and opposite outwardly directed faces, said arms being pivoted intermediate said ends and adapted for clamping engagement with the outer surfaces of the walls of an arterial vessel;

spring means resiliently biasing said arms into clamping position; and

a layer of ceramic material on the opposite outwardly directed faces of said clamping arms, said ceramic material disposed to accept tissue growth from the surrounding tissue.

24. The aneurysm clip of claim 23 wherein said clamp comprises a layer of ceramic material on said opposed clamping faces.

25. The aneurysm clip of claim 23 or 24 wherein said ceramic material comprises hydroxy-apatite.

26. A method of stabilizing an aneurysm clip having a pair of clamping arms with opposed clamping faces and opposite outwardly directed faces comprising the step of fixedly applying a layer of ceramic material to the oppositely, outwardly directed faces.

27. The method of claim 26 wherein said method further comprises applying a layer of ceramic material to said opposed clamping surfaces.

28. The method of claim 26 or 27 wherein said ceramic material comprises hydroxyapatite.